REMARKS

I. Introduction

Applicants respectfully request reconsideration of the present application in view of the foregoing amendments and in view of the reasons which follow.

After amending the claims as set forth above, claims 1-20 are now pending in his application. Claims 1 and 8 have been amended. Claims 15-20 have been added. Support for the amendments to claims 1 and 8 may be found, for example, in paragraph 29 of the specification. Support for claims 15-20 may be found, for example, in the originally filed claims 1-14 and in paragraphs 22, 25 and 29 of the specification. No new matter was added.

II. The § 103(a) rejections should be withdrawn

In the Office Action, claim 1 was rejected under 35 U.S.C. 103(a) as being unpatentable over Shimizu et. al. in view of Tamatani et al. and Oversluizen. Claims 1 and 2 were rejected under 35 U.S.C. 103(a) as being unpatentable over Ishikawa et al. in view of Tamatani et al. and Watanabe et al. Claims 1-3, 5 and 6 were rejected under 35 U.S.C. 103(a) as being unpatentable over Japanese Patent Laid-open No. Hei 11-71581 in view of Tamatani et al. Claim 4 was rejected under 35 U.S.C. 103(a) as being unpatentable over Japanese Patent Laid-open No. Hei 11-71581 in view of Tamatani et al. and further in view of Yocom et al. Claims 8, 9, and11-13 were rejected under 35 U.S.C. 103(a) as being unpatentable over Japanese Patent Laid-open No. Hei 11-71581 in view of Tamatani et al. and further in view of Beers et al. Claim 10 was rejected under 103(a) as being unpatentable over Japanese Patent Laid-open No. Hei 11-71581 in view of Tamatani et al. and further in view of Beers et al. and Yocom et al. Claims 7 and 14 were rejected under 35 U.S.C. 103(a) as being unpatentable over Japanese Patent Laid-open No. Hei 11-71581 in

view of Tamatani et al. and further in view of Beers et al., and further in view of Bechtel et al. These rejections are respectfully traversed.

Independent claims 1 and 8 recite a vacuum ultraviolet ray excitable phosphor having an improved green light emitting efficiency when excited by a vacuum ultraviolet ray, such as a ray having a wavelength of 200 nm or less.

The phosphor of claim 1 of the present application has a crystal structure and consists essentially of a composition expressed by a general formula:

$L_{1-x}Tb_xAl_3(BO_3)_4$

where L denotes at least one element selected from Y and Gd, and x is a number satisfying $0.1 < x \leq 0.7$.

This phosphor is a Tb activated rare earth aluminum borate phosphor which contains a relatively high concentration of Tb as an activator. The claimed phosphor has a rare earth aluminum borate host lattice, which is excellent in absorption efficiency of the vacuum ultraviolet ray. The amount of the Tb activator substituted for the L element (i.e., Y and/or Gd) can be set high by using the rare earth aluminum borate host lattice. Thus, when this phosphor is excited by vacuum ultraviolet radiation, the light emitting efficiency of green light emission can be improved as compared with a conventional green emitting phosphor.

The phosphor of claim 8 has a crystal structure and consists essentially of a composition expressed by the general formula of $L_{1-x-y}Tb_xCe_yAl_3(BO_3)_4$, where L denotes at least one element selected from Y and Gd, and x and y are numbers satisfying $0.1 < x \leq 0.7$ and $0.00001 \leq y \leq 0.01$. Thus, the phosphor of claim 8 further contains a small amount of Ce as an activator, in addition to the Tb activator. The addition of the Ce activator improves the luminance efficiency of the phosphor.

Out of the large number of prior art references used in the §103(a) rejections in the Office Action, only two references, Tamatani and Oversluizen, disclose rare earth aluminum borate as a host lattice of the phosphor. The other references disclose completely different phosphors with different host lattices. However, both Tamatani and Oversluizen do not disclose or suggest the general formula recited in claims 1 and 8 and do not disclose or suggest the claimed Gd, Y, Tb, and/or Ce atomic ratio. Furthermore, Oversluizen teaches a glass which is amorphous and does not have a crystal structure of the phosphors of claims 1 and 8. Thus, even if the references could be combined as suggested in the Office Action, the combination would not disclose or suggest the phosphor having all limitations of claims 1 or 8 of the present application.

A. <u>The rejection over Shimizu in view of Tamatani and Oversluizen</u>

Shimizu discloses a YAG:Ce phosphor represented by a general formula $(Y_{1-p-q-r}Gd_pCe_qSm_r)_3(Al_{1-s}Ga_s)_5O_{12}$, where $0 \leqq p \leqq 0.8$, $0.003 \leqq q \leqq 0.2$, $0.0003 \leqq r \leqq 0.08$ and $0 \leqq s \leqq 1$ (col. 4, lines 10-18). This phosphor is activated by Ce and does not contain boron. Shimizu does not disclose or suggest a rare earth aluminum borate as the host lattice of the phosphor and Tb as the activator of the phosphor. Thus, the phosphor of Shimizu is very different from the Tb activated rare earth aluminum borate phosphor of claim 1.

As noted in the Office Action, Tamatani teaches a rare earth aluminum borate phosphor activated by Ce and Tb as a green emitting phosphor (col. 1, lines 60-65). However, this portion of Tamatani does not disclose the composition of the rare earth aluminum borate phosphor. Thus, Tamatani fails to teach or suggest the phosphor composition $L_{1-x}Tb_xAl_3(BO_3)_4$ as recited in claim 1 of the present application.

Oversluizen discloses an alumino-silicate and/or alumino-borate <u>glass</u> comprising lanthanum and/or gadolinium and activated by a rare earth metal such as Tb and/or Ce (col. 1, lines 45 - 56). Therefore, since the material of

Oversluizen is a glass, Oversluizen fails to teach the phosphor having a crystal structure as claimed in amended claim 1. Furthermore, one of ordinary skill in the art would not be motivated to combine the amorphous glass of Oversluizen with the crystal phosphors of Shimizu and Tamatani. Glasses and crystalline phosphors have very different properties. One of ordinary skill in the art would not expect that rare earth ions having certain properties in glass would have the same properties in a crystalline phosphor.

Even if there was motivation (which there is not) to combine Shimizu with Tamatani and Oversluizen, this combination would not result in the phosphor having the general formula recited in claim 1 because none of these references discloses a phosphor having this formula. Thus, even if there was motivation to substitute the YAG:Ce phosphor of Shimizu with a rare earth aluminum borate phosphor of Tamatani, the resulting phosphor would not have the general formula recited in claim 1, since there could be many different rare earth aluminum borate phosphor compositions. For example, claim 1 recites that more than 10% of the L element is substituted by the Tb activator. There is no teaching or suggestion in these applied references that the Tb activator should be present in the phosphor in such concentration.

B. <u>The rejection over Ishikawa in view of Tamatani and Watanabe</u>

Ishikawa discloses a green light emitting phosphor excited by a vacuum ultraviolet ray, the phosphor comprising Tb activated yttrium silicate. In col. 6, Table 5, terbium-activated yttrium silicate phosphor represented by $(Y_{093}\ Tb_{007})_2\ SiO_5$ is shown as an example. However, Ishikawa does not disclose or suggest an aluminum borate phosphor, as recited in claim 1. Ishikawa also does not disclose using Tb as an activator to substitute more than 10% of Y. Therefore, the phosphor of Ishikawa is significantly different from the phosphor of claim 1.

As noted above, Tamatani teaches a rare earth aluminum borate phosphor activated by Ce and Tb as a green emitting phosphor (col. 1, lines 60-65).

However, this portion of Tamatani does not disclose the composition of the rare earth aluminum borate phosphor. Thus, Tamatani fails to teach or suggest the phosphor composition $L_{1-x}Tb_xAl_3(BO_3)_4$ as recited in claim 1 of the present application.

Watanabe discloses a rare earth silicate phosphor co-activated by Ce and Tb expressed by the general formula of $La_{2(1-x-y)}O_{3-z}SiO_2:Ce_{2x}\cdot Tb_{2y}$. As an example (col. 5, line 5), a phosphor composition $Y_{1.68}O_3SiO_2:Ce_{0.02}Tb_{0.32}$ is disclosed. Therefore, Watanabe does not disclose or suggest a rare earth aluminum borate as the host lattice of the phosphor, as claimed in claim 1. Watanabe does not teach or suggest that a large amount of Tb activator would also be effective in an aluminum borate phosphor. Since phosphor properties vary unpredictably with phosphor composition, one of ordinary skill in the art would not expect that Tb activator concentration of the silicate phosphor of Watanabe would be effective in an aluminum borate phosphor from the teaching of Watanabe.

Even if there was motivation (which there is not) to combine Ishikawa with Tamatani and Watanabe, this combination would not result in the phosphor having the general formula recited in claim 1 because none of these references discloses a phosphor having this formula. Thus, even if there was motivation to substitute the yttrium silicate phosphor of Ishikawa with a rare earth aluminum borate phosphor of Tamatani, the resulting phosphor would not have the general formula recited in claim 1, since there could be many different rare earth aluminum borate phosphor compositions.

C. The rejections over JP 11-71581 in view of Tamatani

1. Claims 1-3, 5 and 6

Japanese Patent Laid-open No. Hei 11-71581 ("JP 11-71581") discloses a Tb activated rare-earth borate phosphor expressed by $(Y_{1-x-y},Gd_x,Tb_y)_2O_3\cdot B_2O_3$, where $0.08 \leqq x \leqq 0.8$, $0.05 \leqq y \leqq 0.25$, and $0.13 \leqq x + y \leqq 1.0$. Therefore, this

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reference teaches a borate phosphor but does not disclose or suggest the claimed rare earth aluminum borate phosphor.

As noted above, Tamatani teaches a rare earth aluminum borate phosphor activated by Ce and Tb as a green emitting phosphor (col. 1, lines 60-65). However, this portion of Tamatani does not disclose the composition of the rare earth aluminum borate phosphor. Thus, Tamatani fails to teach or suggest the phosphor composition $L_{1-x}Tb_xAl_3(BO_3)_4$ as recited in claim 1 of the present application.

Even if there was motivation (which there is not) to combine JP 11-71581 with Tamatani, this combination would not result in the phosphor having the general formula recited in claim 1 because none of these references discloses a phosphor having this formula. Thus, even if there was motivation to substitute the borate phosphor of JP 11-71581 with a rare earth aluminum borate phosphor of Tamatani, the resulting phosphor would not have the general formula recited in claim 1, since there could be many different rare earth aluminum borate phosphor compositions.

2. **Claim 4**

Regarding the rejection of claim 4 over JP 11-71581 in view of Tamatani and further in view of Yocom, Applicants note that Yocom discloses a phosphor having a rhombohedral crystal structure and the empirical formula(α Ma γ Mc $\delta/2$ Md)(β Mb $\delta/2$ Md ε Me)S_2 ,where Ma is at least one monovalent cation selected from Na, K, Rb and Cs, Mb is at least one trivalent cation selected from Gd, La, Lu, Sc and Y, Mc is at least one monovalent cation selected from silver, copper and thallium, Md is at least one divalent cation selected from europium, manganese, lead and tin, Me is at least one trivalent cation selected from arsenic, bismuth, cerium, dysprosium, erbium, praseodymium, antimony, samarium, terbium and thulium, and S is sulfur. Therefore, Yocom's composition is completely different from the phosphor composition of the claims

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1 and 4. Yocom fails to teach the rare earth aluminum borate as the host lattice of the phosphor. One of ordinary skill in the art would not be motivated to form a rare earth aluminum borate phosphor with a rhombohedral crystalline structure given the teaching of Yocom because the phosphor of Yocom having the rhombohedral crystalline structure is so different from a rare earth aluminum borate phosphor. Thus, Yocom does not remedy the deficiencies of JP 11-71581 and Tamatani

3. Claims 8, 9 and 11-13

Regarding the rejection of claims 8, 9 and 11-13 over JP 11-71581 in view of Tamatani and further in view of Beers, Applicants note that Beers discloses a fluorescent lamp phosphor comprising a plurality of fine-sized crystals having the general formula of $Ce_{1-x-y}La_xTb_yMg_zAl_{11}O_{19}$, wherein La is an optional constituent. However, Beers does not disclose or suggest a rare earth aluminum borate as the host lattice of the phosphor, and is silent with respect to the phosphor being able to be excited by a vacuum ultraviolet ray. Beers provides no teaching or suggestion that a rare earth aluminum borate should be activated by both Tb and Ce.

Accordingly, there is no motivation to combine the phosphor of Beers with the phosphors of JP 11-71581 and/or Tamatani. Even if there was motivation (which there is not) to combine JP 11-71581 with Tamatani and Beers, this combination would not result in the phosphor having the general formula recited in claim 8 because none of these references discloses a phosphor having this formula. Thus, even if there was motivation to substitute the borate phosphor of JP 11-71581 with a rare earth aluminum borate phosphor of Tamatani, the resulting phosphor would not have the general formula recited in claim 1, since there could be many different rare earth aluminum borate phosphor compositions.

4. Claim 10

Regarding the rejection of claim 10 over JP 11-71581 in view of Tamatani and further in view of Beers and Yocom, applicants noted above that Beers and Yocom do not remedy the deficiencies of JP 11-71581 in view of Tamatani. Thus, there is no motivation to arrive at the phosphor of claim 10 from these four references for the reasons discussed above.

5. Claims 7 and 14

Regarding the rejection of claims 7 and 14 over JP 11-71581 in view of Tamatani, further in view of Beers, and further in view of Bechtel, applicants note that claims 7 and 14 are dependent on claim 1 and claim 8, respectively, and are considered to be allowable at least for the same reasons as claims 1 and 8. Furthermore, Bechtel discloses a plasma display with a phosphor screen comprising a phosphor composition of an UV-phosphor furnished with a coating which includes one or more catena-polyphosphates of metals of the group formed by the alkaline earth metals (Abstract). Thus, since this catena-polyphosphate coated phosphor is different from the catena-polyphosphates uncoated phosphors of JP 11-71581, Tamatani and Beers, one of ordinary skill in the art would not expect that the uncoated phosphors of JP 11-71581, Tamatani and Beers would be suitable for a plasma display.

III. Conclusion

Applicants believe that the present application is now in condition for allowance. Favorable reconsideration of the application as amended is respectfully requested. The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application.

Respectfully submitted,

Date 12/31/02

By ______ Reg No. 43445

FOLEY & LARDNER
Washington Harbour
3000 K Street, N.W., Suite 500
Washington, D.C. 20007-5143
Telephone: (202) 672-5414
Facsimile: (202) 672-5399

Richard L. Schwaab
Attorney for Applicant
Registration No. 25,479

Should additional fees be necessary in connection with the filing of this paper, the Commissioner is hereby authorized to charge Deposit Account No. 19-0741 for any such fees.

MARKED UP VERSION SHOWING CHANGES MADE

Below are the marked up amended claims:

1. (Amended) A phosphor excited by a vacuum ultraviolet ray provided with a green light emitting phosphor when excited by the vacuum ultraviolet ray, the phosphor <u>having a crystal structure and</u> consisting essentially of a composition expressed by a general formula:

$L_{1-x}Tb_xAl_3(BO_3)_4$

[(In the-formula,] <u>where</u> L denotes at least one [of] element selected from Y and Gd, and x is a number satisfying $0.1 < X \leqq 0.7$ [)].

8. (Amended) A phosphor excited by a vacuum ultraviolet ray provided with a green light emitting phosphor when excited by the vacuum ultraviolet ray, the phosphor <u>having a crystal structure and</u> consisting essentially of a composition expressed by a general formula:

$L_{1-x-y}Tb_xCe_yAl_3(BO_3)_4$

[(In the-formula,] <u>where</u> L denotes at least one [of] element selected from Y and Gd, and x and y are numbers satisfying $0.1 < x \leqq 0.7$ and $0.00001 \leqq y \leqq 0.01$ [)].